PATENT SPECIFICATION

DRAWINGS ATTACHED

962,576

962,576

Date of Application and filing Complete Specification May 15, 1961.
No. 17662/61.
Application made in Germany (No. R28003 VI/5c) on May 19, 1960.
Application made in Germany (No. R28691 VI/5c) on Sept. 7, 1960.
Complete Specification Published July 1, 1964.

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Index at acceptance: —E1 E2D3A

International Classification:—E 21 d

COMPLETE SPECIFICATION

Improvements in or relating to Clamping Devices

We, RHEINSTAHL WANHEIM G.M.B.H. a German Company, of Duisburg-Wanheim, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a clamping device for clamping by frictional engagement parts of a bearing or supporting device which are movable axially in relation to one another, more particularly for friction-type pit-props having two or more clamping elements adapted to be driven independently of one another.

The friction-type props used in mining consist of on outer prop, an inner prop slidable telescopically therein, and a clamp which is connected to the outer prop and in which the inner prop can be fixed by frictional engagement. These props are relatively inexpensive, robust and insensitive to rough treatment underground. They have serious disadvantages however. For example it is not easy so to place the props that all the props take substantially the same amount of load. The reason for this lies in the construction of the prop clamps which, although they give satisfactory results as a rule on the test bench, frequently exhibit relatively dangerous divergences in load carrying when used underground.

In obtaining clamping tensions by means of wedges it is important whether the wedge is subjected to a steady slowly increasing force, for example by means of hydraulic devices, or whether the wedge is driven in by blows with a hammer. In the latter case, the blows produce vibrations in the wedge, and these have considerable influence on the friction factor of the wedge sliding surfaces. The blow energy applied therefore has different effects depending on how the hammer blow meets the wedge.

When the clamp wedge is driven in by blows with a hammer, as is usually the case, the result is therefore clamping loads which differ considerably in practice, particularly since the energy to be applied for driving in the wedge depends entirely on the prop setter and accordingly may differ considerably.

In order to set props with a high clamping load of the maximum uniformity a pit-prop clamping device has been proposed wherein a clamping wedge is mounted in an outer wedge which is adapted to expand transversely to its longitudinal direction. The clamping wedge can be driven independently of the outer wedge, and it expands the latter in these conditions. The two edges are driven in by hammer blows. The outer wedge is driven in first to take up the play provided in the clamp and to produce a certain clamping tension in the clamp. In order to increase the clamping tension to the required amount, the clamping wedge situated in the outer wedge is then driven in. Since the clamping wedge has a relatively small inclination and can also be lubricated on its sliding surfaces, a very high clamping tension can be obtained in the clamp with the application of a normal amount of force.

The object of the invention is to improve such a clamping device consisting of two wedges disposed one inside the other. It is a particular object of the invention to simplify the manipulation of the clamping device in such manner that when the outer wedge is released the clamping wedge mounted in it is automatically returned to its initial position so that it is not necessary to release and drive the clamping wedge back separately.

According to the invention such a clamping device comprises an outer wedge made up of two or more parts movable relatively to each other in a direction transverse to the axis of the outer wedge so that this may be transversely expanded to give the required clamping pressure, and a clamping wedge mounted within the outer wedge so that it can move from an initial position axially relatively to

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the outer wedge with little frictional resistance and thereby transversely expand the outer wedge, the clamping wedge having or having associated with it a screw-threaded part co-operating with a further screw-threaded part so that relative rotation of these parts causes axial movement of the clamping wedge within the outer wedge, and one of the screw-threaded parts being constructed so that it automatically opens to release the other screw-threaded part when the device is removed from use, and the clamping pressure is thus removed from the outer wedge, so allowing the outer wedge freely to contract transversely with no external restraint.

The friction of the clamping wedge sliding surfaces may be reduced by lubricating the sliding surfaces or by the provision of anti-friction bearings, and also if required, by special combinations of material and special material treatment.

Preferably, the clamping wedge is subject to a spring bias which automatically returns the clamping wedge into its initial position when the reaction to the clamping pressure is removed from the outer wedge.

Conveniently the screw-threaded part that automatically opens is an axially divided nut which bears against a part of the inner surface of the outer wedge. The axially divided nut may be either separate from the clamping wedge, or the clamping wedge may be axially divided into two parts, the axially divided nut being also formed in two parts, each part being connected to or forming part of the clamping wedge.

Examples of the clamping devices embodying the invention are illustrated in the accompanying drawings, wherein:—

Figure 1 is a diagrammatic side view of a friction-type pit-prop.

Figure 2 is a plan view of a clamping device acording to the invention.

Figures 3—5 are a diagrammatic longitudinal section through the outer wedge in another embodiment of a clamping device according to the invention.

Figures 6—9 are of a third example of embodiment of the invention, Figures 6,8 and 9 being a longitudinal section while Figure 7 is a cross-section on the line VII—VII of Fig. 6.

Figure 1 shows the fundamental construction of a pit prop. The prop consists, in known manner, of an outer prop 1, which has a base plate 1*a* and in which an inner prop 2 with a head plate 2*a* is arranged to be telescopically slidable. The inner prop 2 can be fixed in relation to the outer prop 1 in any desired position by frictional engagement. The clamp 3 is used for this purpose, and is situated at the top end of the outer prop and contains a clamp gear.

The clamp gear shown in simplified form consists of a horizontal wedge 5 which bears against an abutment 4 in the clamp. The wedge acts on the inner prop 2 by way of a clamping jaw 6, the inner prop 2 in this way being fixed in the clamp by friction.

There are numerous different forms of construction for the clamp gear. In practically all cases the clamping tension in the clamp is produced by a clamp wedge which is applied and released by hammer blows. The clamp wedge is usually mounted horizontally in the clamp.

Instead of the clamp wedge 5 shown in Figure 1, the invention provides a clamping device consisting of two wedges disposed one inside the other.

Figure 2 shows schematically the simplest form of clamping device embodying the invention, and illustrates clearly the principles involved. The device consists of an outer wedge 11 and an inner or clamping wedge 15 mounted therein. The outer wedge 11 is made in two parts. It has an expanding jaw part 12 which can be expanded transversely to the longitudinal direction of the outer wedge. The parts 11 and 12 are locked together by suitable means, for example by teeth or projections 13 and 14, in such a manner that they can slide in relation to one another in the transverse direction but not in the longitudinal direction. As is conventional for pit prop clamp wedges, the outer wedge has a self-locking surface 17, i.e. the wedge inclination of this surface is such that after it has been driven into the clamp the wedge cannot be pressed back again automatically under the action of the clamping forces.

The clamping wedge 15 is situated between the two parts 11 and 12 of the outer wedge. It is longitudinally slidable against the force of a return spring 19 in the chamber formed by the parts 11 and 12. A clamping screw 16 mounted by means of a screw-thread in the outer wedge projection 14 serves to displace the clamping wedge 15. The wedge surface 18 of the clamping wedge 15 is in this case such that there is no self-locking action. In the clamping position the clamping wedge 15 is prevented from slipping back by the clamping screw 16.

The wedge surface 18 and the surface 18*a* of the clamping wedge 15 bear against the corresponding surfaces of the parts 11 and 12 of the outer wedge with reduced friction. The friction can be reduced by anti-friction bearings or by lubrication of the sliding surfaces.

The parts 11 and 12 of the outer wedge are advantageously connected together in such manner as to form a closed housing for the clamping wedge 15. The clamping wedge 15 and its sliding surfaces are in this way protected against dirt and damage due to dust and so on.

It may be advantageous to associate clamping elements, for example springs, with the two longitudinal parts 11 and 12 of the outer

wedge, which elements tend to draw the two parts 11 and 12 towards the centre axis, i.e. towards one another. Expansion of the two parts 11 and 12 by the driving in of the clamping wedge 15 takes place against the clamping action of these clamping elements.

The clamping device shown in Figure 2 is preferably arranged as a transverse or horizontal wedge in the pit prop clamp as shown in Figure 1. In these conditions, the longitudinal part 12 may bear against the clamping jaw 6 and the longitudinal part 11 against the bearing element 4. The clamping forces acting in the horizontal direction are then transmitted by the clamping jaw 6 to the inner prop 2 which in turn bears directly or indirectly against the back wall of the clamp housing.

In order that the inner prop 2 may be fixed in the clamp 3 with frictional engagement in a certain extended position, i.e. in order to set the prop, the outer wedge 11 is first driven into the clamp by application of hammer blows to the head surface 10, the clamping jaw 6 being pressed against the inner prop 2. In order that the clamping tension produced in this way may be greatly increased in the clamp, the clamping wedge 15 which is mounted in the outer wedge with much lower friction is driven in. This is effected by tightening the clamping screw 16, the head of which is countersunk in a recess 20 of the impact surface 10. The clamping screw 16 is advantageously operated by means of a spanner, for example a torque spanner. By displacement of the clamping wedge 15 against the restoring force of the spring 19 the parts 11 and 12 of the outer wedge are expanded with an increase of the clamp tension in the direction of the arrow B. Since the clamping wedge is mounted with very low friction in its sliding surfaces 18 and 18*a*, high clamp tensions can be obtained with small torques, i.e. with the application of little force. The magnitude of the clamp tensions can be accurately regulated. It is thus possible to set all the props with same load in a working.

Dismantling of the prop is advantageously effected by knocking back the outer wedge 11, for which purpose it is only necessary to apply a few hammer blows to the thinner end 13. The clamp can also be removably released by releasing the clamping wedge 15. When the outer wedge is knocked back, the clamping wedge 15 is automatically pushed back into its initial position by the return spring 19 as soon as the clamping screw 16 is released.

It may be advantageous to construct the clamping device and/or the prop clamp in such manner that the clamping device can without difficulty be changed for a standard clamp wedge. Since the clamping device according to the invention may prove to be somewhat larger than a standard clamp wedge, special fillers may be provided for the clamp to compensate the difference in sizes of these parts. The fillers are removed from the clamp when the clamping device is inserted or are changed from smaller fillers. When the clamping device is changed for a standard wedge, the fillers can be once again inserted in the clamp or, if required, exchanged.

In order to avoid any turning back of the clamping screw 16 when the clamping device is relieved of stress, the screwthread of the outer wedge in which the clamping screw 16 is mounted must be constructed as a screwthread which is divided in the longitudinal direction and one half of which is provided on the part 11 while the other half is provided on the part 12, although this has not been shown in Figure 2 to make this Figure as clear as possible. Thus the part 14 is so connected to the part 12 that in the assembled state of the outer wedge the two screwthread parts combine to form a closed screwthread in which the clamping screw 16 engages. A divided construction of the screwthread in this way has the advantage that when the outer wedge is knocked back the screwthread engagement of the clamping screw 16 opens automatically as a result of the forcing apart of the parts 11 and 12 and hence the transverse displacement of the screwthread parts connected thereto. In these conditions the clamping screw 16 is returned into the initial position, i.e. the released position, by means of the wedge 15 on which they may be rotatably mounted and which slides back under the action of the spring 19.

The following examples of embodiment of the invention show in more detail systems in which the co-operating screwthread required on the outer wedge for the clamping means 16 is so constructed and arranged as to open automatically when the outer wedge is knocked back.

In the embodiment shown in Figures 3—5, the clamping device also consists of an outer wedge 101 of two-part construction. The two longitudinal halves 101*a* and 101*b* of the outer wedge again have self-locking wedge surfaces 101*c*. The outer wedge is constructed as an impact wedge, i.e. it can be driven into the clamp by hammer blows applied to its wide impact surface and be released again by hammer blows applied to its narrow impact surface 101*e*.

Expansion of the longitudinal parts 101*a* and 101*b* in the direction of the arrow B is effected by means of a clamping wedge 102 which is arranged to be axially movable in the outer wedge constructed as a hollow element. The slope of the clamping wedge 102 in this exemplified embodiment corresponds to the slope of the outer wedge 101, i.e. it has self-locking wedge surfaces 102*a*. The clamping wedge slides with its wedge surfaces 102*a* against wedge-shaped internal surfaces of the outer wedge 101 having the same slope

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as the clamping wedge 102. The friction at the sliding surfaces 102*a* is much less than the friction at the sliding surfaces 101*c* of the outer wedge, and this effect can be achieved by lubrication of the surfaces or by the provision of anti-friction bearings at the clamping wedge sliding surfaces. The clamping wedge 102 advantageously moves in a lubricant filling of the outer wedge, which in these conditions is shut off from the exterior so as to be dust-proof.

Tightening of the clamping wedge 102 is effected by means of a spindle 103 which has a screwthreaded part 103*a* and a shank 103*b* without a screwthread, the end of which engages by a collar 104 in a recess 105 in the clamping wedge 102 and is mounted to be axially movable with a certain clearance therein but is not withdrawable from the recess. Between the collar 104 and the base of the recess 105 is a compression spring 106 which presses the screwthreaded spindle 103 up until its collar 104 bears against a projection 107 on the clamping wedge.

The two parts 108*a* and 108*b* of an axially divided nut 108 are mounted around the spindle 103. The nut bears by its outer surfaces against the inclined surfaces 109 inside the outer wedge, these surfaces diverging in the axial direction (arrow A). The inclination of the inclined surfaces 109 is in the opposite direction to the inclination of the wedges 101 and 102. The halves 108*a* and 108*b* of the nut are guided along the inclined surfaces 109 in such manner that they are prevented from rotation but can slide axially along these surfaces.

The parts 108*a* and 108*b* of the nut are connected to the clamping wedge 102 by tension springs 110. The later are disposed in projections 111 on the longitudinal parts 101*a* and 101*b* of the outer wedge.

A ring 112 is disposed at the wide end of the outer wedge 101 and is pressed upwards, i.e. in the direction of the wide end of the outer wedge, by means of a spring 115 disposed in the outer wedge. The ring 112 has a collar 113 co-operating with projections 114 on the top end of the outer wedge. On the expansion of the longitudinal halves 101*a* and 101*b* the parts 113 and 14 come to bear against one another so that the expansion movement is limited. The spindle 103 is taken through an annular disc 112 and held in the latter. A similar device is provided at the thin end of the outer wedge, as shown by the reference numerals 112*a*, 113*a* and 114*a*.

The spindle 103 has facilities for the application of a spanner or the like, for example a hexagon 103*c*, which lies in a recess 116 of the wide head of the outer wedge. A torque spanner can be applied from outside to the hexagonal head 103*c* to drive the clamping wedge 102 in the direction of the arrow A. Alternatively, a motor constructed as a portable hand unit can be used for this purpose.

Figure 3 shows an arangement wherein the outer wedge 101 is driven into the prop clamp by hammer blows. The clamp wedge 102 is not yet tensioned in these conditions. In these conditions occurring during the setting of the prop the screwthread 103*a* of the spindle 103 is not yet in engagement with the two-part nut 108.

To clamp the clamping wedge 102, the spindle 103 is pressed in the direction of the arrow A against the pressure of the spring 106 until the screwthread 103*a* comes into contact with the screwthread of the nut 108. The spindle is then turned to bring about engegement of the screwthread. During the first revolutions of the spindle the clamping wedge is not yet driven, since the connection between the spindle and the clamping wedge has a certain amount of play in the recess 105. The advantage of this is that the clamping forces do not become operative until at least a number of turns of the screwthread of the nut 108 and the spindle 103 are in engagement with one another. This avoids any damage to the screwthread by the clamping forces.

The final conditions during the clamping of the clamping wedge 102 are shown in Figure 4. It will be seen that the clamping wedge is slid in the transverse direction as soon as the rotating spindle bears by its collar 104 against the base 105*a*, the longitudinal halves 101*a* and 101*b* of the outer wedge being expanded in the direction of the arrows B. During the displacement of the clamping wedge 102 the nut 108 slides along the inclined strips 109 in the direction of the arrow C without rotating, since it is prevented from rotating at the inclined strips. The spring 110 connecting the nut 108 and the clamping wedge 102 are tensioned during this process, as shown in Figure 4.

An exactly regulated clamp tension can be produced by way of the clamping wedge 102 with the aid of the torque spanner or motor. The clamp tension acts as a normal force transversely to the longitudinal axis of the prop or perpendicularly to the frictional surfaces of the iner prop.

Figure 5 shows the clamping device according to Figures 3 and 4 in a state after the outer wedge 1 has been knocked back. Knocking back is effected, as stated, by blows with a hammer applied to the thin end 101*e* of the outer wedge. During the knocking back operation the tension in the clamp is eliminated. The longitudinal halves 101*a* and 101*b* of the outer wedge can freely expand in the direction of the arrow B, since there is sufficient clearance in the relieved clamp, and this is effected by expanding means, such as springs or like resilient means, which are not shown. During this operation, the springs 110 draw the clamping wedge 102 and the nut 108 automatically

into their initial position shown in Figure 3, the screwthread engagement between the spindle 103 and the nut 108 being released by the expansion of the outer wedge.

Figures 6—9 show a somewhat modified embodiment of the invention. The construction of the outer wedge is particularly different, and in this case it has a one-piece housing 118 with impact surfaces 118*a* and 118*b*, on which two jaws 119 with self-locking wedge surfaces 119*a* and 119*b* are mounted laterally to be transversely movable. The clamping wedge is also made in two parts in this case. It consists of two longitudinal halves 120*a* and 120*b*, which are arranged to be longitudinally movable inside the outer wedge. The halves 121*a* and 121*b* of the axially divided nut 121 are disposed on the longitudinal halves 120*a* and 120*b* of the clamping wedge 120. The longitudinal halves 120*a* and 120*b* of the clamping wedge and the parts 121*a* and 121*b* of the nut 121 disposed thereon slide by their wedge surfaces 120*c* against the wedge-shaped inside surfaces 119*d* of the jaws 119 with reduced friction. The slope of the clamping wedge 120 corresponds to that of the jaws 119. Strips 117 are provided in the wedge housing 118 and against them the parts 120*a* and 120*b* of the clamping wedge are guided. The strips 117 prevent any movement of the longitudinal parts 120*a* and 120*b* towards the centre line, which movement might bend the spindle 122.

The spindle 122 is situated between the longitudinal parts 120*a* and 120*b* of the clamping wedge 120. Here again it has a screwthreaded part 122*a* followed by a shank 122*b* without a screwthread, which engages in a recess 118*c* of the thick end of the outer wedge 118. A spring 123 lies on the spindle 122 and bears at one end against a collar 124 rigidly provided on the spindle and at the other end against a disc 125 movable on the spindle. The disc 125 bears against the ends of the clamping wedge halves 120*a* and 120*b*. The hexagonal head or the like 122*c* of the spindle is in this case taken out of the thin end of the outer wedge. It lies in a recess 118*d*. Rings 126 are placed around the jaws 119 in the longitudinal direction of the outer wedge and seal off the interior of the wedge housing and also spread the jaws 119 resiliently outwards.

The longitudinal parts 120*a* and 120*b* of the clamping wedge lie and slide in grooves 119*c* of the jaws 119 (Figure 7). The arrangement is such that when the jaws 119 are spread apart in the direction of the arrow B the parts 120*a* and 120*b* of the clamping wedge and, together with them, the parts 121*a* and 121*b* of the nut are driven.

The abutment 118*e* for the spindle 122 is provided at the base of the recess 118*c* of the housing 118.

Figure 6 shows the clamping device in a state in which the outer wedge has been driven into the clamp by the aplication of a few hammer blows to the surface 118*a*. To tension the clamping wedge, the torque spanner is applied for example to the hexagonal head 122*c* of the spindle 122 and the spindle, the screwthread 122*a* of which is not yet in engagement with the screwthread of the nut 121, is pressed in the direction of the arrow C until the two screwthreads come into contact. The spindle is then turned, so that the screwthreads engage with one another. During the first revolutions of the spindle the clamping wedge is not yet driven. Only when the end of the spindle bears against the abutment 118*e* in the recess 118*c*, i.e. when a number of turns of the screwthreads of the spindle and nut are already in contact, are the parts of the clamping wedge 120 and of the nut 121 tightened in the direction of the arrow A by rotation of the spindle, the jaws 119 expanding in the direction of the arrow B with an increase in the clamp tension. The spring 123 is tensioned during the displacement of the clamping wedge.

The state in which the clamping wedge 120 is tensioned in the outer wedge 118 is shown in Figure 8. This state corresponds to the operational state of the loaded prop.

To remove the prop, the outer wedge 118 is driven back in the clamp by application of hammer blows to its thin end 118*b*. As a result of the relieving of the clamping device the jaws 119 are expanded outwards by the restoring force of the rubber spring rings 126 and the spring 123, the longitudinal parts 120*a* and 120*b* of the clamping wedge and parts 121*a* and 121*b* of the nut being driven as a result of locking the jaw 119 (Figure 9). During this operation, the screwthread engagement between the nut 121 and the screwthread 122*a* of the spindle is opened. The spindle can therefore be displaced under the action of the spring 123 in the direction of the arrow A and the clamping wedge 120 together with the nut 121 can be moved in the direction of the arrow C so that the initial state as shown in Figure 6 is restored.

As already stated, the inclination of the clamping wedge is made such that the wedge gear has the optimum transmission enabling very high clamping tensions to be produced with tolerable force expenditure. The head of the screwthreaded spindle may be disposed either at the thick end or at the thin end of the outer wedge as shown in the various exemplified embodiments.

Unlocking devices or indicating devices may be provided between the clamping screw or the screwthreaded spindle and the clamping wedge to show the extent of the clamping wedge tension and thus permit simple control of the prop setting according to the invention.

The invention is not restricted to the em-

bodiments described. For example, in the embodiments shown in Figures 6—9 it is possible to provide just a single expanding jaw 119 with a single clamping wedge half 120. In these conditions it is naturally necessary for the spindle to be suitably borne on the rear side where the other clamping wedge half is situated in the exemplified embodiment. These modifications in no way affect the principle of the clamping device. They simply give a simplification and also a reduction of the overall size of the clamping device.

WHAT WE CLAIM IS:—

1. A clamping device for use in clamping together two relatively axially movable parts of a bearing or supporting device such as a friction-type pit prop, the device comprising an outer wedge made up of two or more parts movable relatively to each other in a direction transverse to the axis of the outer wedge so that this may be transversely expanded to give the required clamping pressure, and a clamping wedge mounted within the outer wedge so that it can move from an initial position axially relatively to the outer wedge with little frictional resistance and thereby transversely expand the outer wedge, the clamping wedge having or having associated with it a screw-threaded part cooperating with a further screw-threaded part so that relative rotation of these parts causes axial movement of the clamping wedge within the outer wedge, and one of the screw-threaded parts being constructed so that it automatically opens to release the other screw-threaded part when the device is removed from use, and the clamping pressure is thus removed from the outer wedge, so allowing the outer wedge freely to contract transversely with no external restraint.

2. A clamping device according to Claim 1, in which the clamping wedge is subject to a spring bias which automatically returns the clamping wedge into its initial position when the reaction to the clamping presure is removed from the outer wedge.

3. A clamping device according to Claim 1 or 2, in which one of the screw-threaded parts has a shaft extending from the threaded part and the end of the shaft is countersunk in a recess on one of the two end surfaces of the outer wedge.

4. A clamping device according to Claim 3 in which the end of the shaft is shaped to receive a torque spanner or output shaft of a portable hand-operated motor.

5. A clamping device according to any one of the claims 1 to 4 in which the screw-threaded part that automatically opens is an axially divided nut which bears against a part of the inner surface of the outer wedge.

6. A clamping device according to Claim 5 in which the axially divided nut is separate from the clamping wedge, and the separate parts of the nut are locked on the parts of the outer wedge in such a way that when the device is removed from use and the outer wedge freely expands transversely, the parts of the nut move with the parts of the outer wedge to open the nut.

7. A clamping device according to Claim 6 in which the separate parts of the nut are locked to the parts of the outer wedge by keys and keyways allowing relative axial movement of the nut and outer wedge but not relative rotation.

8. A clamping device according to Claim 6 or Claim 7 insofar as dependent from Claim 2 in which the spring bias for returning the clamping wedge to its initial position is provided by springs extending axially between the axially divided nut and the clamping wedge.

9. A clamping device according to Claim 5 in which the clamping wedge is axially divided into two parts and the axially divided nut is also formed in two parts, each part being connected to or forming part of one part of the clamping wedge.

10. A clamping device according to Claim 9 in which each part of the clamping wedge is guided within the outer wedge.

11. A clamping device according to Claim 9 or Claim 10 in which the axially divided nut has associated with it a spring device, the spring force of which biases the two parts of the nut away from each other.

12. A clamping device according to any one of Claims 9 to 11 insofar as dependent on Claim 2 or 3 in which the spring bias for returning the clamping wedge to its initial position acts on the shaft.

13. A clamping device according to any one of Claims 5 to 12 in which the shaft of the said one of the screw-threaded parts is so constructed that when the axially divided nut is closed during insertion of the outer wedge to the clamping position the two screw-threaded parts do not engage each other.

14. A clamping device according to Claim 13 in which the shaft is spring biased so that the two screw-threaded parts only engage on axial displacement of the shaft.

15. A clamping device according to Claim 13 or 14 in which the shaft, in its initial position is close to an abutment on the outer wedge, and comes into engagement with the abutment only after a number of revolutions.

16. A clamping device according to any one of the preceding claims in which means are provided to limit the transverse expansion of the outer wedge.

17. A clamping device according to Claim 16 in which the means consists of a disc which is provided with stops.

18. A clamping device substantially as described and as illustrated in Figures 3 to 5 or to Figures 6 to 9 of the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1964.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

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7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet I

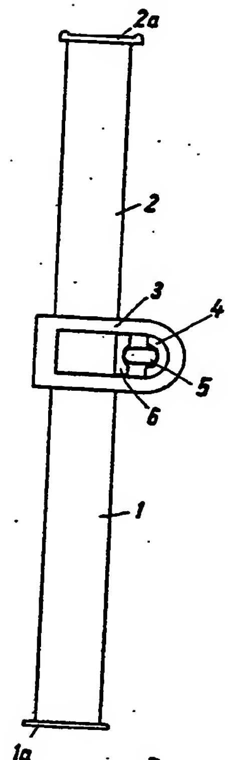

Fig. 1

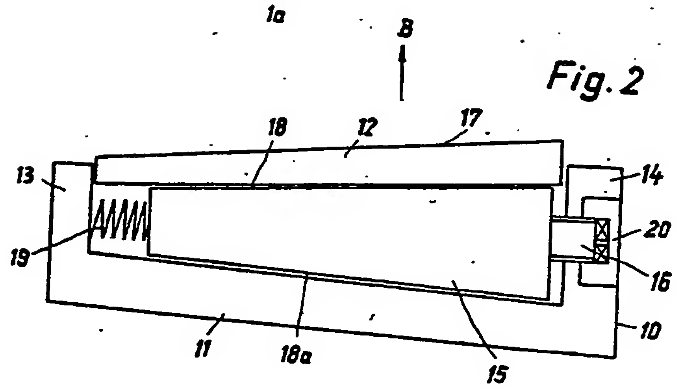

Fig. 2

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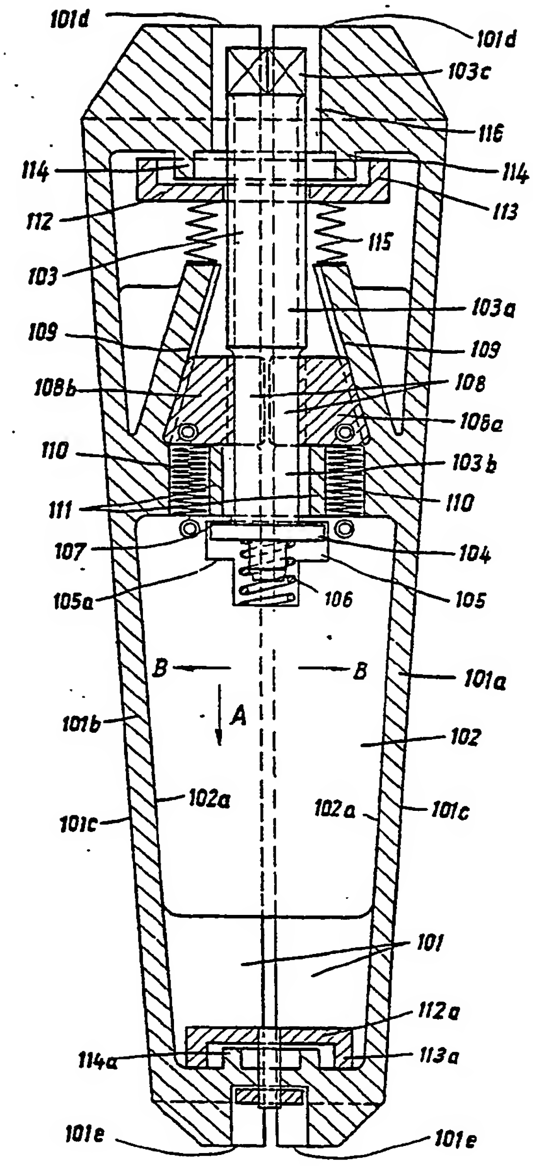
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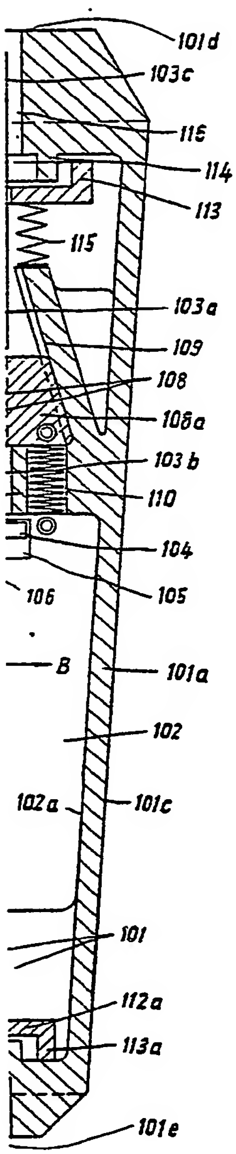
Fig.3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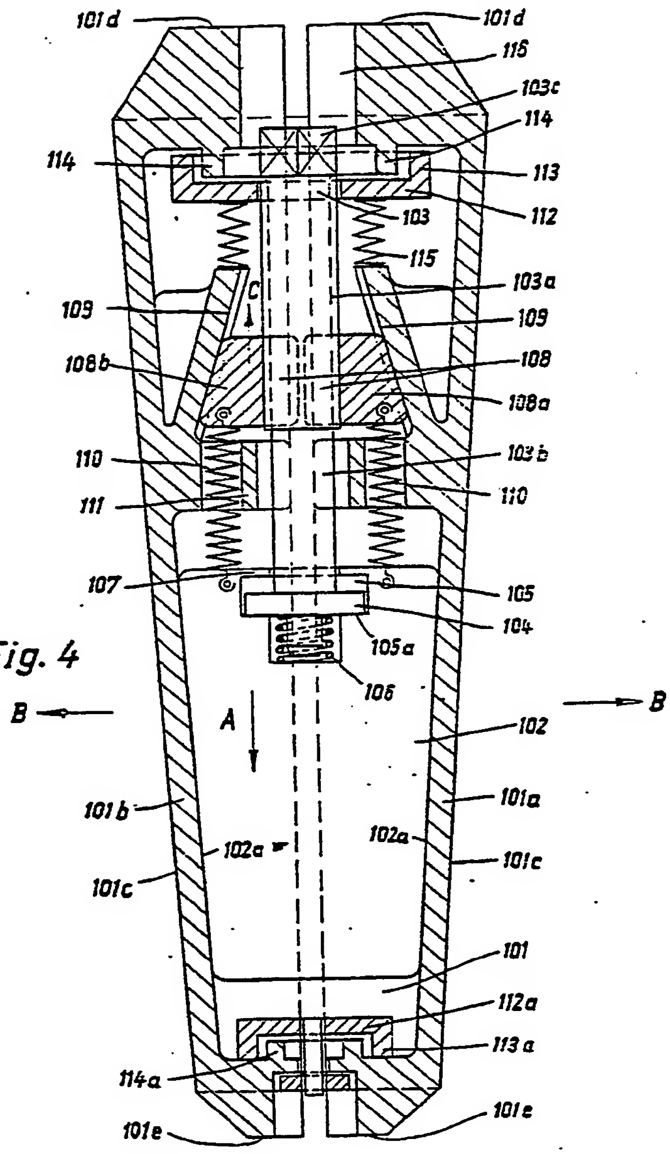
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Fig. 4

962576 COMPLETE SPECIFICATION

7 SHEETS This drawing is a reproduction of the Original on a reduced scale Sheets 2 & 3

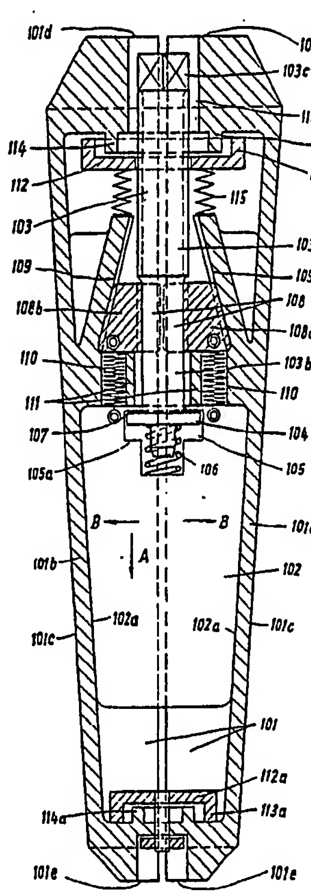

Fig.3

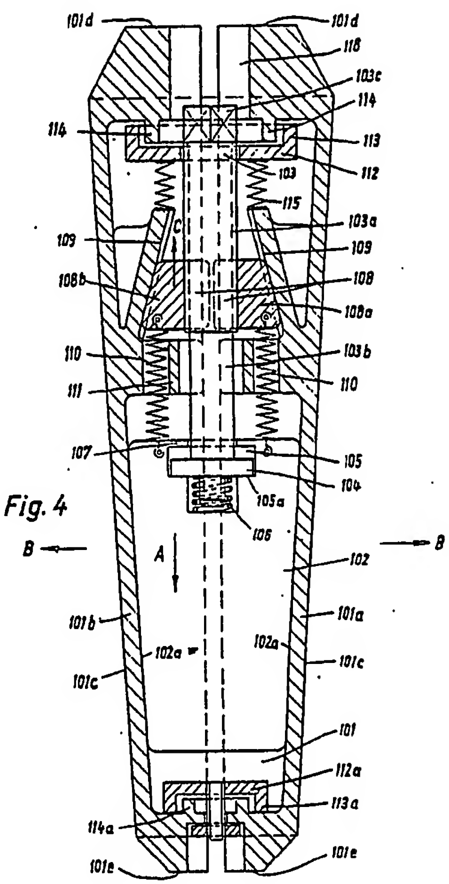

Fig. 4

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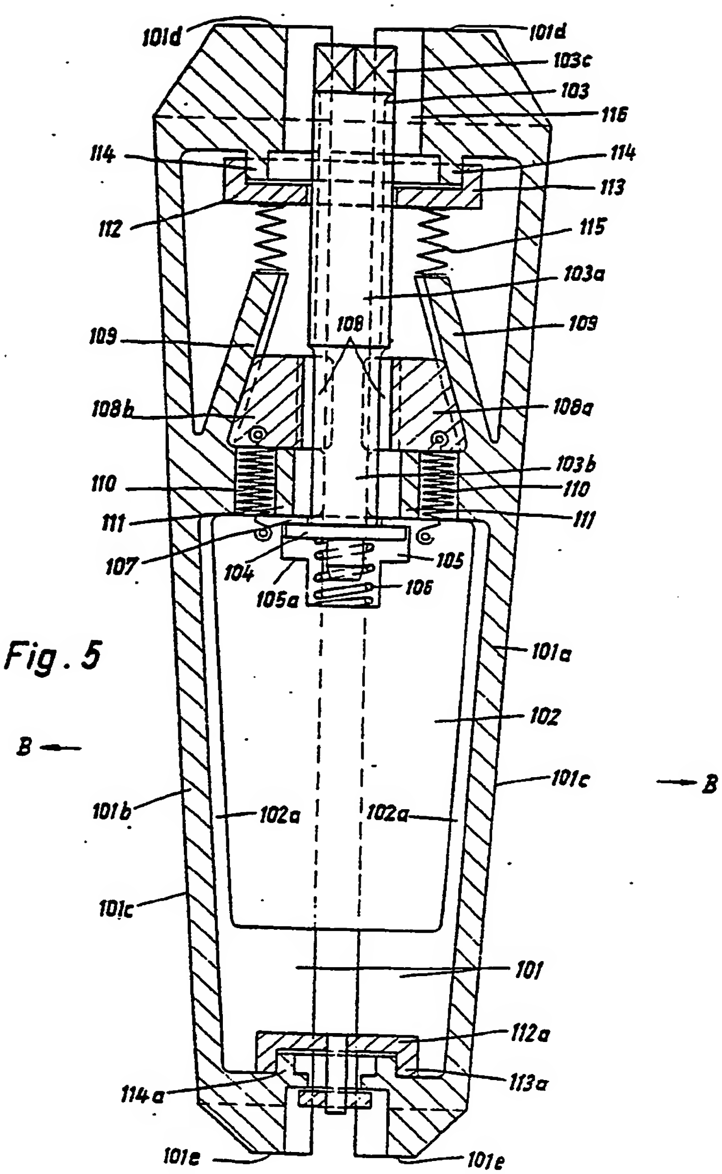

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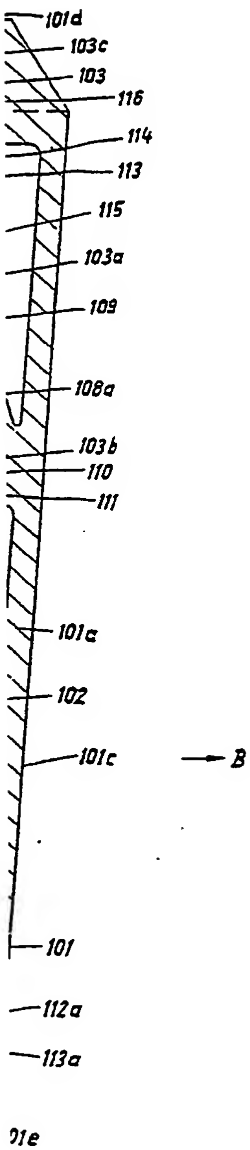
Fig. 5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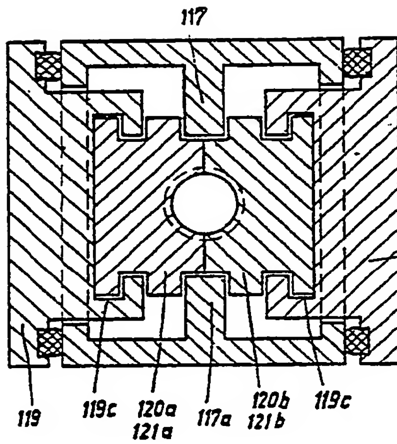
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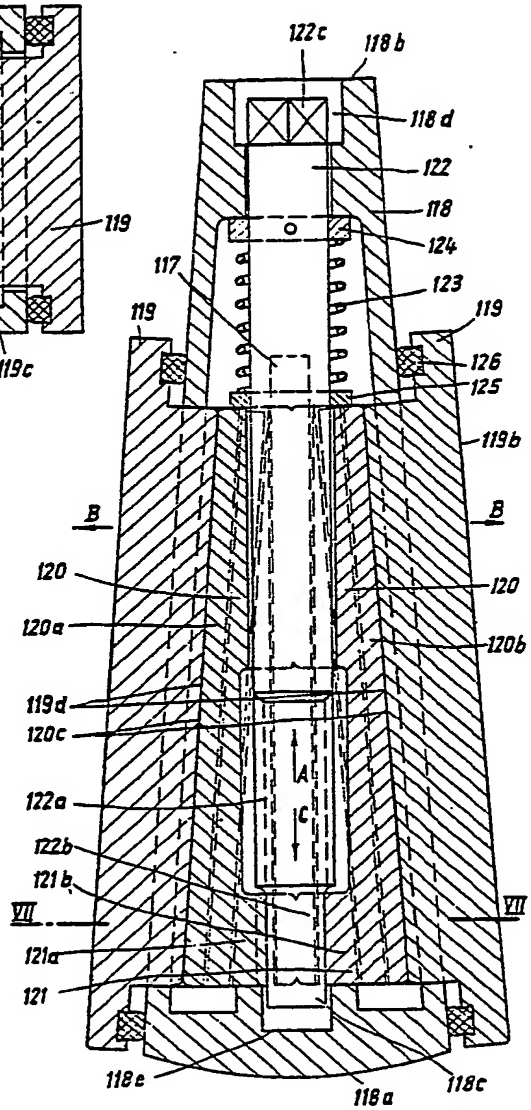
Fig. 7

Fig. 6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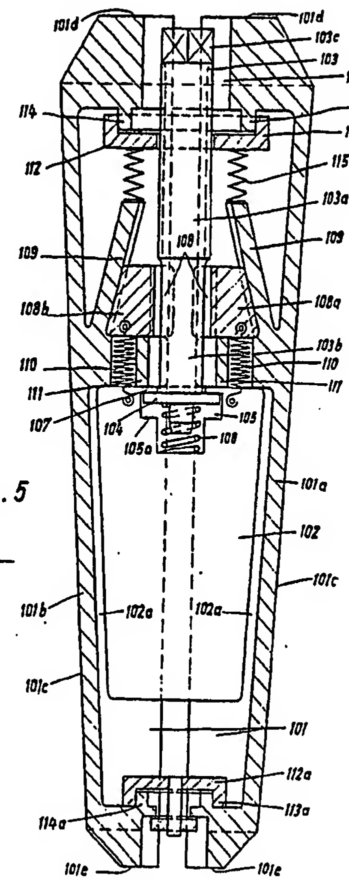

Fig. 5

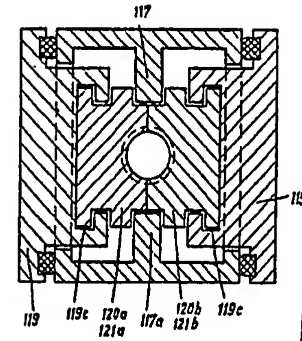

Fig. 7

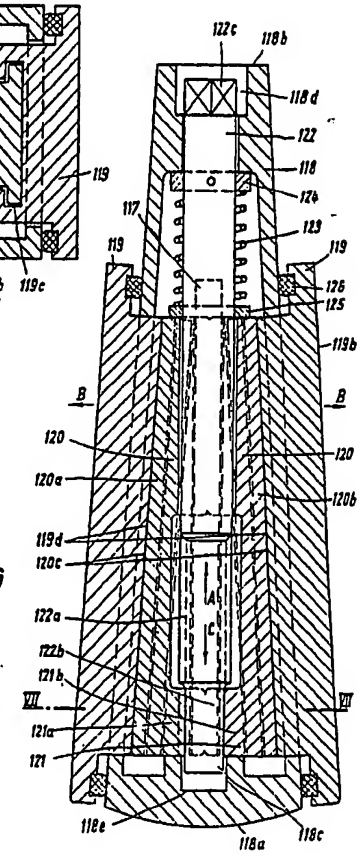

Fig. 6

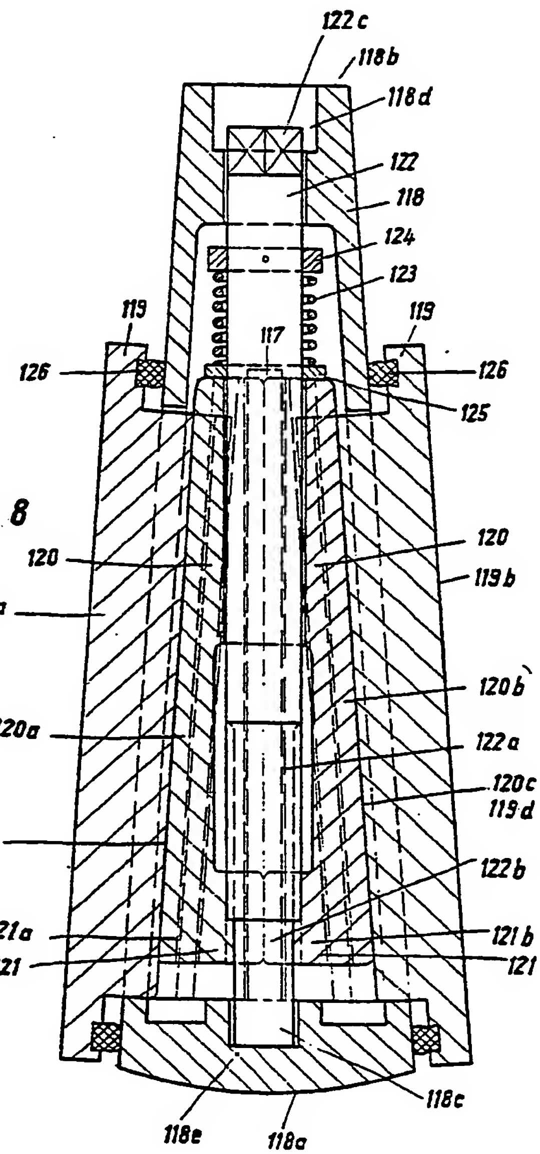
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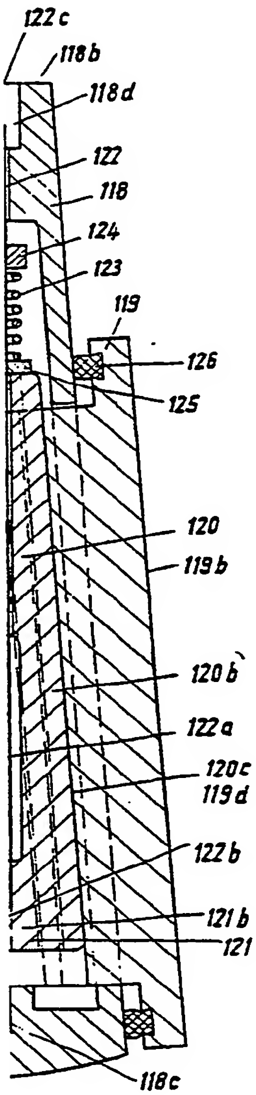
Fig. 8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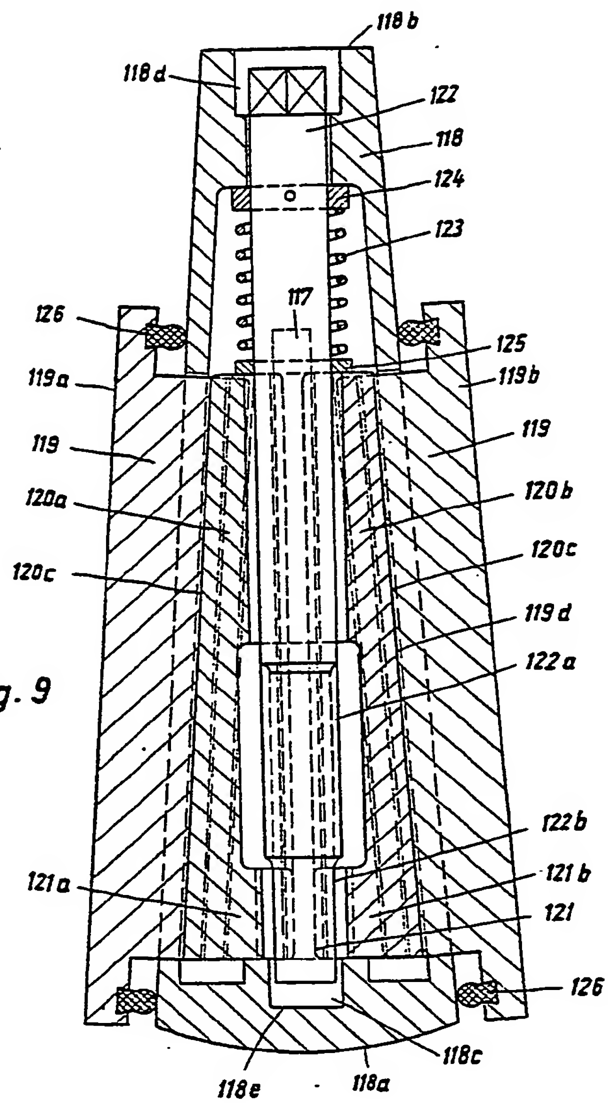
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Fig. 9

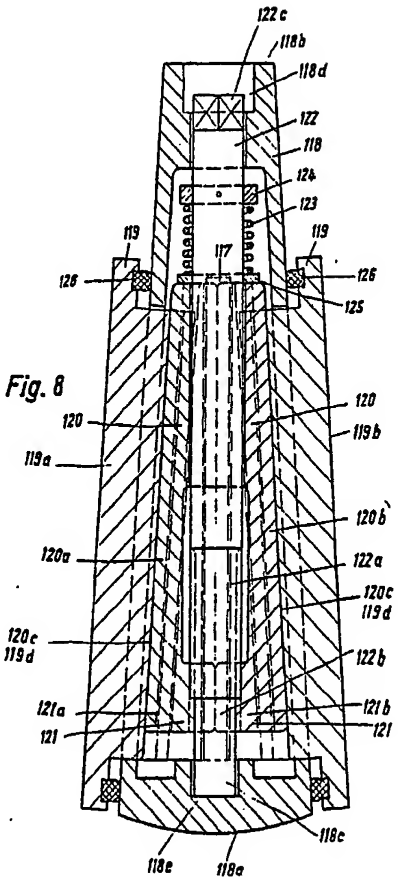
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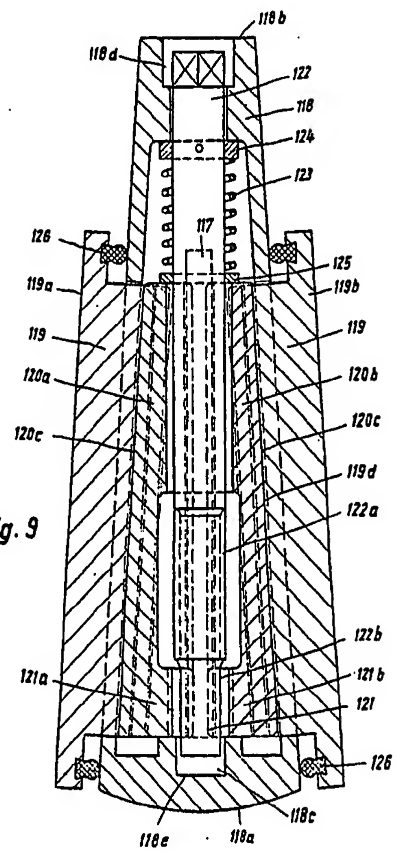
Fig. 8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122a
122b
121a
121b
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126
118c
118e
118a

Fig. 9

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